



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:  
**MAGUIRE et al.**

Serial No.: 10/713,101  
Filed: 11/17/03

Group: 3745  
Examiner: VERDIER, Christopher M.

Title: COOLED TURBINE ASSEMBLY

**PRIORITY CLAIM SUBMISSION AND CERTIFIED COPY**

Date: May 23, 2006

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

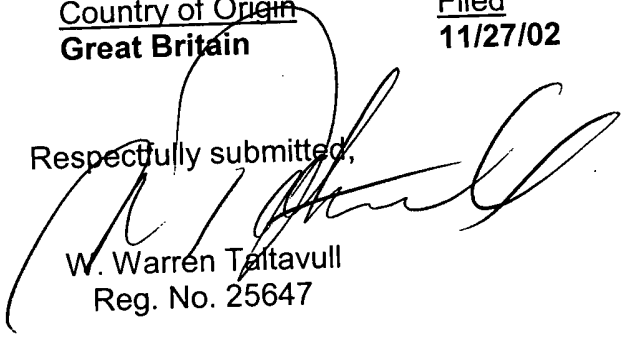
It is respectfully requested that under the provisions of 35 USC 119/365, this application be given the benefit of the foreign filing date of the following, a certified copy of which is attached hereto:

Application No.  
**0227640.0**

Country of Origin  
**Great Britain**

Filed  
**11/27/02**

Respectfully submitted,

  
W. Warren Taitavull  
Reg. No. 25647

MANELLI DENISON & SELTER PLLC  
2000 M Street N.W. Suite 700  
Washington D.C. 20036  
202 261 1047

**THIS PAGE BLANK (USPTO)**



INVESTOR IN PEOPLE

The Patent Office  
Concept House  
Cardiff Road  
Newport  
South Wales  
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

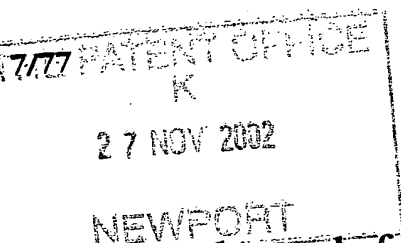
Signed

*Hebehen*

Dated 7 October 2003

CERTIFIED COPY OF  
PRIORITY DOCUMENT

**THIS PAGE BLANK (USPTO)**



7/77

# Statement of inventorship and of right to grant of a patent

The Patent Office

Cardiff Road  
Newport  
South Wales  
NP10 8QQ

1. Your reference

DY3049

2. Patent application number  
(if you know it)

0227640.0

27 NOV 2002

3. Full name of the or of each applicant

ROLLS-ROYCE PLC

4. Title of the invention

COOLED TURBINE ASSEMBLY

5. State how the applicant(s) derived the right from the inventor(s) to be granted a patent

BY VIRTUE OF AN AGREEMENT DATED 15 NOVEMBER 2002

6. How many, if any, additional Patents Forms 7/77 are attached to this form?  
(see note (c))

2

7.

I/We believe that the person(s) named over the page (and on any extra copies of this form) is/are the inventor(s) of the invention which the above patent application relates to.

Signature

Date

M A GUNN

26.11.2002

8. Name and daytime telephone number of person to contact in the United Kingdom

M A GUNN

01332 249457

## Notes

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there are more than three inventors, please write the names and addresses of the other inventors on the back of another Patents Form 7/77 and attach it to this form.
- When an application does not declare any priority, or declares priority from an earlier UK application, you must provide enough copies of this form so that the Patent Office can send one to each inventor who is not an applicant.
- Once you have filled in the form you must remember to sign and date it.

Enter the full names, addresses and postcodes of the inventors in the boxes and underline the surnames

ALAN ROBERT MAGUIRE  
19 HAWTHORN CRESCENT  
FINDERN  
DERBY  
DE65 5AN

Patents ADP number (if you know it):

7202823001

PAUL WILLIAM FERRA  
12 CORNFLOWER DRIVE  
OAKWOOD  
DERBY  
DE21 2SA

Patents ADP number (if you know it):

8514440001

Reminder

Have you signed the form?

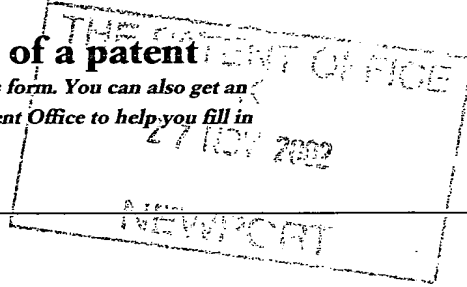
Patents ADP number (if you know it):



27NOV02 E766662-1 D00370  
P01/7700 0.00-0227640.0

# Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)



The Patent Office

Cardiff Road  
Newport  
South Wales  
NP10 8QQ

1. Your reference

DY3049

2. Patent application number

(The Patent Office will fill in this part)

0227640.0

27 NOV 2002

3. Full name, address and postcode of the or of each applicant (underline all surnames)

ROLLS-ROYCE PLC  
65 BUCKINGHAM GATE  
LONDON  
SW1E 6AT

Patents ADP number (if you know it)

850 4375001

If the applicant is a corporate body, give the country/state of its incorporation

ENGLAND

4. Title of the invention

COOLED TURBINE ASSEMBLY

5. Name of your agent (if you have one)

M A GUNN

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

ROLLS-ROYCE plc  
PATENTS DEPARTMENT  
PO BOX 31  
DERBY  
DE24 8BJ

Patents ADP number (if you know it)

3962001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number  
(if you know it)

Date of filing  
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

YES

- a) any applicant named in part 3 is not an inventor, or
  - b) there is an inventor who is not named as an applicant, or
  - c) any named applicant is a corporate body.
- See note (d))

# Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form

Description

4

Claim(s)

2

Abstract

1

Drawing(s)

1

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

3

Request for preliminary examination and search (Patents Form 9/77)

1

Request for substantive examination (Patents Form 10/77)

1

Any other documents (please specify)

DEPOSIT ACCOUNT FEE SHEET

11.

I/We request the grant of a patent on the basis of this application.

Signature

M A GUNN

Date

26.11.2002

12. Name and daytime telephone number of person to contact in the United Kingdom

M A GUNN

01332 249457

## Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

## Notes

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- For details of the fee and ways to pay please contact the Patent Office.



COOLED TURBINE ASSEMBLY

The present invention relates to a cooled turbine assembly for use in a gas turbine engine. The invention  
5 has particular efficacy when used in a gas turbine engine for the purpose of powering an aircraft.

It is known to provide air from a compressor of an associated gas turbine engine, for the purpose of cooling the engine turbine structure, ie at least the respective  
10 first high pressure high temperature stage of nozzle guide vanes, and/or the immediately following high pressure high temperature stage of turbine blades. Cooling is achieved by passing air bled from the compressor into passageways formed in the aerofoils of the respective vanes and blades,  
15 then ejecting the air into the gas annulus via slots in the trailing edges of the aerofoils.

Some turbine designs incorporate a stage of turbine blades which lie in a gas annulus, wherein that part of which surrounding the stage of blades, is constructed from  
20 a number of segments known as shroud segments. The known method of cooling such a structure is to provide a flow of compressor air over the radially outer surface of the segments, the flow path being defined between those radially outer surface and a surrounding casing.

25 The present invention seeks to provide an improved cooled turbine structure.

According to the present invention a cooled turbine structure comprises adjacent stages of guide vanes and turbine blades, wherein said turbine blades are surrounded  
30 in spaced relationship by hollow shroud segments that are connected via respective upstream ends to said guide vanes, leaked air from a central spaced volume in a gas turbine engine when operatively associated therewith, the passage of said leaked air from said central space volume to said

hollow shroud segment interiors being enabled by pipe members extending through said guide vanes which connect said space volume and said hollow shroud segment interiors in flow series and wherein said shroud segments include a  
5 leaked air exit aperture in their respective downstream edges.

The invention will now be described by way of example and with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a gas turbine  
10 engine of the kind appropriate for the inclusion therein of a cooled turbine structure in accordance with the present invention.

Figure 2 is an enlarged cross sectional view of cooled turbine structure in accordance with the present invention.

15 Figure 3 is an enlarged part view of the shroud segment of Figure 2.

Referring to Figure 1 a gas turbine engine 10 includes a compressor 12, combustion equipment 14, a turbine structure 16, and an exhaust duct 18. The turbine  
20 structure 16, has a stage of guide vanes 20, immediately followed by a stage of turbine blades 22, the latter being connected to a rotary shaft 24, via a rotor disk 26.

Referring to Figure 2 the stage of turbine blades 22 is surrounded in radially spaced relationship by a ring of  
25 shroud segments 28, which together make up the outer wall of that part of the gas annulus 30 within which blade stage 22 rotates.

Each shroud segment 28 is hollow and in the present example its interior is divided by a wall 31 into outer and  
30 inner compartments 32 and 34 with respect to the axis 36 of the shaft 24. Compartments 32 and 34 are connected in flow series by a plurality of small holes 38 in their dividing wall 31 and wall 31 is spaced from the innermost wall by support pillars 39, all of which is best seen in Figure 3.

Referring back to Figure 2 the leading edge 40 of each shroud segment 28 locates in a slot 42 that expands laterally of the axis of a respective tube 44 at its outer end, one of which tubes resides within each guide vane 20. 5 The radially inner end of each tube 44 projects into a common annular compartment 46, which is provided for the receipt of contaminated air that during operation of the engine 10 leaks through various seal structures (not shown) within the general engine structure and collects in the 10 space volume 48 between the combustion equipment 14 and shaft 24 (Figure 1).

During the said operation of engine 10 air deliberately bled from compressor 12 is passed through pipes 50, only one of which is shown, and which terminate 15 in swirl vanes 52. The majority of the bled air on exiting the swirl vanes 52, flows through passageways 54 and 56 into the interior of the aerofoil of each turbine blade 22 so as to cool them in known manner. The remainder of the bled air leaks through seal 58 to augment the contaminated 20 air in compartment 46. The mixed flow then passes through pipes 44 into the outer compartments 32 in respective shroud segments 28 and thence via holes 38 into the inner compartments 34 to impingement cool the shroud segments 28 inner walls. The mixed flow then passes around pillars 39 25 which generates turbulence in the flow, thus increasing cooling efficiency and finally exits the shroud segments 28 via slots 60 in their trailing edges into the gas annulus.

During engine operation the gas flow passes across the exit slots 60 and generates a pressure drop in that region. 30 This phenomenon boosts the mixed flow rate through pipes 44 and so ensures efficient cooling of the shroud segments 28. Moreover use of leaked air as the main cooling medium for that purpose, obviates the need to provide a further

dedicated compressor bleed supply thus enabling more efficient engine operation.

If a slam acceleration is needed during operation of engine 10 the resulting surge of fuel into the combustion equipment 14 effects a rapid rise in gas temperature which is felt throughout the turbine system. Turbine blade stage 22 rotates at a greater speed which increases the centrifugal force thereon causing the turbine blades to creep, ie to extend their lengths. However guide vanes 20 react to the increased heat by extending even faster thus pivoting shroud segments 28 radially outwards of the engine axis 36 about their downstream ends. To facilitate the pivoting movement the air inlet ends 40 of shroud segments 28 are curved so as to provide point contact only with slots 42. By these means collision between the tips of blades 22 and shroud segments 28 is avoided.

The pivoting capability of the shroud segments 28 as described immediately hereinbefore also enables the adoption of another feature namely the cooling of the casing 64 that surrounds the shroud segments 28 and supports their downstream ends 66. If casing 64 is cooled in the vicinity of the shroud segments 28 at least during normal running of engine 10 shroud segments 28 will be maintained close to the tips of blades 22 thus avoiding excessive clearances and subsequent loss in performance.

Shroud segments 28 have been described hereinbefore as having divided interiors to define compartments 32 and 34. However they could have only one compartment (not shown). In such an arrangement it would be beneficial to retain the pillars 39 so as to maintain strength and turbulence propagation.

Claims

1. A cooled turbine structure comprising adjacent stages of guide vanes and turbine blades, wherein said turbine blades are surrounded in spaced relationship by hollow shroud segments, that are connected via respective upstream ends to said guide vanes leaked air from a central space volume in a gas turbine engine when operatively associated therewith, the passage of said leaked air from said central space volume to said hollow shroud segment interiors being enabled by pipe members extending through said guide vanes which connect said space volume and said hollow shroud segment interiors in flow series and wherein said shroud segments include a leaked air exit aperture in their respective downstream edges.

2. A cooled turbine structure as claimed in claim 1 wherein each hollow shroud segment interior includes a dividing wall so as to provide radially inner and outer compartments with respect to the axis of rotation of a gas turbine engine when associated therewith.

3. A cooled turbine structure as claimed in claim 2 wherein said dividing wall has multiple perforations therein so as to enable leaked air to flow from one compartment to the other compartment.

4. A cooled turbine structure as claimed in claim 3 wherein the direction of flow from one compartment to the other compartment is radially inward with respect to the axis of rotation of a gas turbine engine when associated therewith.

5. A cooled turbine structure as claimed in claim 4 wherein said leaked air exit apertures connect said radially compartment with the gas annulus of a gas turbine engine when associated therewith.

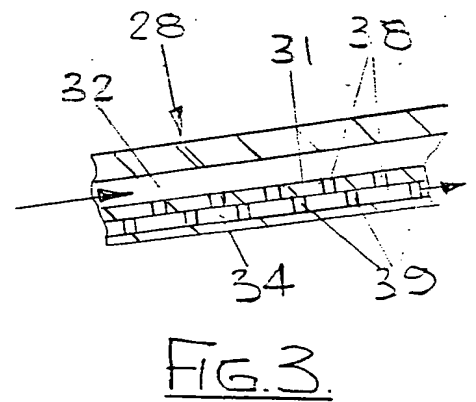
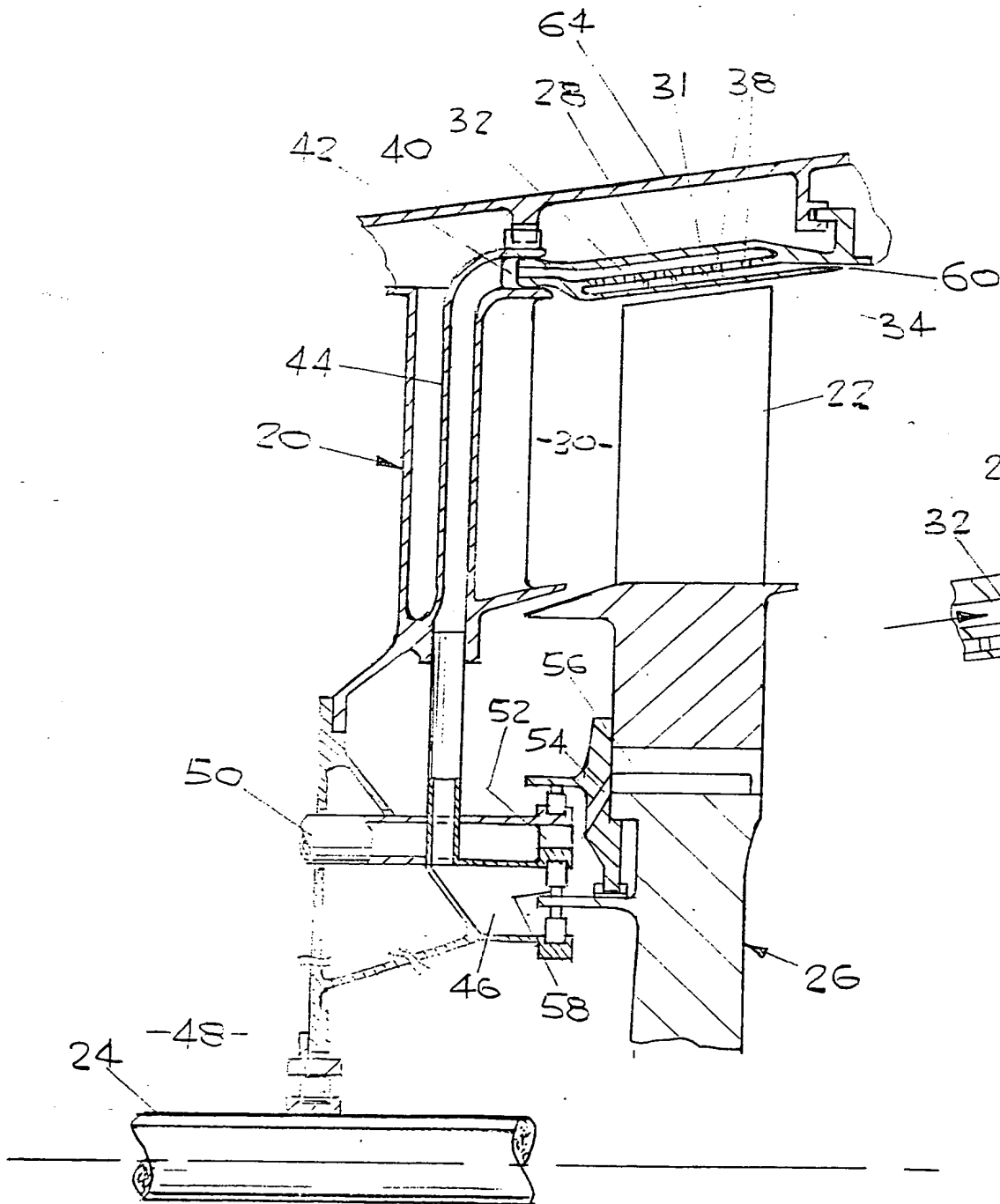
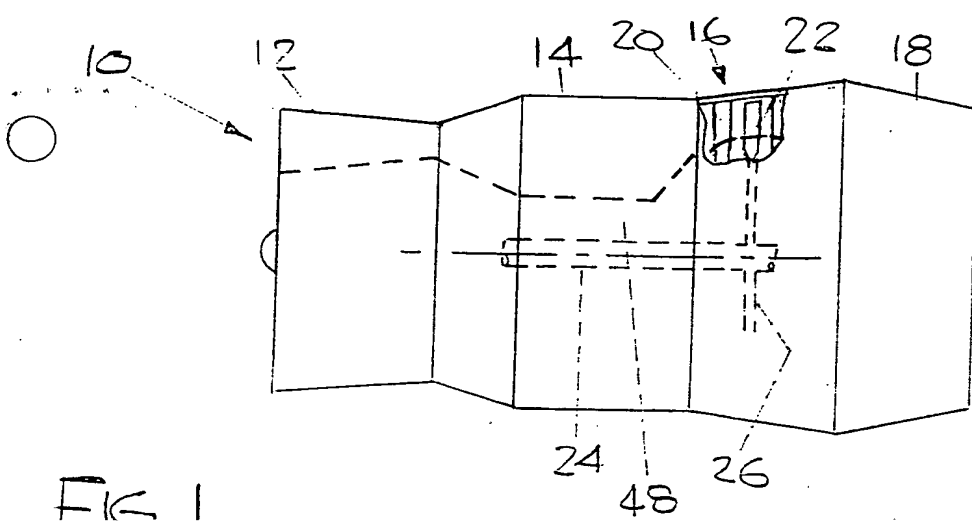
6. A cooled turbine structure as claimed in any of claims 2 to 5 wherein each said dividing wall is spaced from its associated inner wall by pillars.
7. A cooled turbine structure as claimed in any previous claim wherein the leaked air inlet end of each shroud segment is shaped so as to engage said pipe members by point contact only.
8. A cooled turbine structure as claimed in claim 7 wherein the shroud segments are pivotal such that on extension of their respective guide vanes if exposed to excessive heat, said extension pivots said shroud segments away from the tips of their adjacent turbine blades.
9. A cooled turbine structure comprising a stage of guide vanes and stage of turbine blades surrounded by shroud segments substantially as described in this specification and with reference to Figures 2 and 3 of the accompanying drawings.
10. A gas turbine engine including a cooled turbine structure substantially as described in this specification and with reference to Figures 1 to 3 of the accompanying drawings.

ABSTRACT

A gas turbine engine (10) is provided with a stage of turbine blades (22) surrounded by hollow shroud segments (28). Cooling of the shroud segments (28) is achieved by providing a flow of engine leakage air from space volume (48) centrally of the engine (10) via an annular compartment (46) wherein it is diverted away from the blade cooling system and passed via piping (44) within each guide vane (20) to shroud segments (28). The flow impingement cools the shroud segments (28) and then passes into the gas annulus via slots (60).

**THIS PAGE BLANK (USPTO)**





**THIS PAGE BLANK (USPTO)**